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REVIEW—A RECENT CONTRIBUTION TO THE ECOLOGY OF MOSSES

L. W. RIDDLE

The Bryophytes are of special interest to the student of plant evolution as being the first group to adopt the land habit. This change from the aquatic habit of the ancestral algae to the land habit of the bryophytes may be looked upon as one of the most critical changes of environment taking place during the evolution of the plant kingdom. It meant, first of all, that the plants must solve the problem of living without a continuous supply of free water, and, furthermore, of resisting, at least in a dormant condition, the periods of drouth which must necessarily occur. As we should expect, the liverworts, with the exception of certain of the higher genera such as *Frullania*, have advanced a comparatively short distance in the solution of the problem, being mostly still confined to wet habitats. But when we come to the mosses, we find a group distributed over a diversity of habitats, and living successfully even under such severely adverse conditions as exist on tree trunks and on rocks, where they are exposed to the drouths of summer and to the freezing temperatures of winter. Any contribution to our knowledge of the ability of mosses to withstand these conditions is welcome.

We, therefore, turn with interest to a recent paper by Irmscher, "On the Resistance of Mosses to Drying and to Cold"[1] containing the results of an investigation carried on at Leipzig, in the laboratory of Professor Pfeffer, our foremost authority on plant physiology. The paper contains twenty-seven tables giving the statistical results of experiments on a variety of mosses, with a discussion of the data thus obtained and a series of conclusions. In order to give the results of Irmscher's investigations to the readers of the BRYOLOGIST, a translation of the more important of the conclusions is here given, together with some of the data upon which these conclusions are based.

1. Mosses possess in general a great resistance to continuous desiccation by evaporation of the cell sap. Thus, even a moss of wet habitats, such as *Hypnum aduncum*, required 28 weeks of drying before all of the leaf cells were killed.

2. This resistance, however, varies distinctly according to the habitat to which the particular species has become adapted. This may be illustrated by a comparison of the length of time required to kill the leaf cells of mosses growing on soil and of those growing on rocks and trees.

On soil:		On rocks and trees:	
Mnium rostratum	8 weeks	*Ulota Ludwigii*	50 weeks
Funaria hygrometrica	13 weeks	*Orthotrichum speciosum*	60 weeks
Catharinea undulata	25 weeks	*Rhacomitrium canescens*	60 weeks

While the remarkable fact appears that after 128 weeks (nearly two and one half years) of continuous drying, some of the leaf cells of *Grimma apocarpa* still remained alive.

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[1] Edgar Irmscher. Ueber die Resistenz der Laubmoose gegen Austrocknung und Kalte, Jahrbücher für wissenschaftliche Botanik **50**: 387–449. 1912.

3. Furthermore, the drouth-resistance within the species fluctuates according to the water-content of the habitat, becoming adjusted to this water-content through the adaptability of the protoplasm. Thus *Bryum argenteum*, when cultivated in damp air resisted 8 weeks of drying, while the same species cultivated under submerged conditions succumbed in 6 weeks. Still more instructive, however, is the case of species that have grown naturally in different habitats. A striking example of this is seen in *Hypnum aduncum*, where it was found that specimens of a terrestrial form remained alive in part after 20 weeks of drying, while specimens of an aquatic form were killed after 4 weeks.

4. On account of the habit of growth of many mosses in cushions or thick mats, a reduction of the evaporating surface is attained and a consequent retardation of the loss of water during times of drouth. Thus after 18 weeks of drying *Ceratodon purpureus* remained alive if in mats, but was killed if the shoots had been separated.

5. In contrast to a continuous dry period, alternate drying and wetting injures the moss protoplast relatively quickly. For instance, *Bryum capillare* was killed after 10 such alternations.

6. The protonema appears to have a power of drouth-resistance similar in character and amount to that of the leaf cells.

7. The great importance of the calyptra in protecting the young sporogonium is shown by the following comparison:

	with calyptra	without calyptra
Dicranum fuscescens	16 weeks, alive	5 weeks, dead.
Mnium hornum	10 weeks, alive	4 weeks, dead.
Barbula muralis	25 weeks, alive	6 weeks, dead.
Funaria hygrometrica	10 weeks, alive	2 weeks, dead.

8. The determination of the minimum temperature for moss shoots shows that most species resist a temperature of 10° C. (+14° F.) without evident injury, and that the freezing point for the leaves of most species is above —20° C. (—4° F.). At —30° C. (—22° F.) the most resistant species were killed.

9. The freezing point varies according to the temperature prevailing at the time of growth, whence we may conclude that there is a direct adaptability of the vegetative structure to temperature. *Funaria hygrometrica*, when cultivated at +20° C. was partially killed at —5° C.; while material collected out of doors in January was not completely killed even by a temperature of —15° C.

10. The growing points of the moss shoots and the basal cells of the leaves are far superior to the ordinary leaf cells in drouth-resistance and in cold-resistance, and through their regenerative power, after the new intake of water or the return of higher temperatures, form a new system of shoots or protonemata making possible a renewed existence of the individual moss plant.

11. It is shown that there is a relation between the strength of the cell sap

and the power to resist cold, the significance of this being that freezing tends to draw water out from the cells, while the increase in the strength of the cell sap would tend to counteract this.

SULLIVANT MOSS SOCIETY NOTES

A Correction

Plagiothecium geophilum (Aust.) Grout, was found by me at *Sulphur Lick Springs, Ross Co., Ohio,* about nine miles west of Chillicothe, Ohio, *not* at Yellow Springs, Ohio, as given in Dr. Grout's note on p. 53 of the May BRYOLOGIST.

Ross County, Ohio, is a good hunting ground for bryologists, being much cut up by the Scioto River and numerous creeks, which have eroded the surface into gullies and ravines from a few to several hundred feet deep. The wooded sides of these cuts being too steep for cultivation, remain nearly wild land.

Geologically, it is in the Upper Silurian, and good sections from the Waverly shales down to the Niagara limestone are found in different parts of the county. The forests are entirely deciduous, the soil is clay, and the rocks argillaceous shales and limestone.

H. S. JEWETT, M. D.,
Dayton, Ohio.

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EXCHANGE DEPARTMENT

(To Society Members Only—For Postage.)

Mr. George L. Kirk, 21 East Washington St., Rutland, Vt.—*Grimaldia fragrans* (Balb.) Corda.

Dr. George H. Conklin, 1204 Tower Ave., Superior, Wis.—*Lophozia heterocolpa* (Thed.) M. A. Howe and *Scapania irrigua* (Nees) Dumort. From the Duluth-Superior district.

Edward B. Chamberlain, Round Pond, Maine.—*Hypnum hamulosum* B. & S. c. fr., and *Pseudoleskea radicosa* (Mitt.) Kindb.—Collected in Norway by Dr. I. Hagen.

Miss Caroline C. Haynes, Highlands, New Jersey. *Marsupella emarginata* (Ehrh.) Dumort., Adirondack Mts., collected by C. C. Haynes, *Jung. atrovirens* Dumort. Washington, collected by Dr. Frye.

Mr. Geo. B. Kaiser, 564 Locust Ave., Germantown, Pa.—*Andreaea crassinervia* Bruch. Collected in Washington by Prof. T. C. Frye.

Rev. F. S. Beattie, Lincoln, New Hampshire, *Ramalina farinacea* (L.) Ach. Collected in the Philippine Islands.